ENGINEERING DESIGN REPORT
FOR PHASE I REMEDIATION
Olympic Sculpture Park

Prepared for: Museum Development Authority and Seattle Art Museum

Project No. 020118-001-04 • April 14, 2004

ENGINEERING DESIGN REPORT
FOR PHASE I REMEDIATION
Olympic Sculpture Park

Prepared for: Museum Development Authority and Seattle Art Museum

Project No. 020118-001-04 • April 14, 2004

Aspect Consulting, LLC

Lori Herman, CGWP
Principal Hydrogeologist
lherman@aspectconsulting.com

Dave Heffner, P.E.
Associate Remediation Engineer
dheffner@aspectconsulting.com

V:\020118 SAM Olympic Sculpture Park\Phase I EDR FINAL.doc

Contents

List of Tables

List of Figures

List of Appendices

1.0 Introduction

This Engineering Design Report (EDR) presents the basis of design for the Phase I cleanup action at the former Unocal Marketing Terminal property (Site) in downtown Seattle. The Site is being redeveloped as a public park – the Olympic Sculpture Park (OSP) – with landscaped open space dedicated to exhibition of outdoor sculpture. The cleanup action will be conducted by the Museum Development Authority (MDA) pursuant to a Prospective Purchaser Consent Decree (No. 99-2-50226-4 SEA) between the MDA, the Seattle Art Museum (SAM), and the Washington State Department of Ecology (Ecology). This EDR has been prepared in accordance with the Consent Decree and WAC 173-340-400(4)(a).

1.1 Site Description

The Site is located near Pier 70, at the northern end of the waterfront business district in downtown Seattle, Washington (Figure 1). It is bounded to the east by Western Avenue, to the west by Elliott Bay, to the North by Bay Street, and to the South by Broad Street. From the early 1900s to 1975, Unocal used the Site for transfer and distribution of petroleum products. The former Unocal facility contained numerous above-grade product storage tanks, above- and below-grade product pipelines, loading racks, and a tanker loading dock (Pier 71). Products stored or used at the Site included gasoline, diesel fuel, lubricating and heating oils, and petroleum-based solvents. Since 1988, the tanker loading dock and all above-ground structures have been demolished. A pipeline tunnel beneath Elliott Avenue still remains, and abandoned underground fuel lines are still present beneath Alaskan Way and the Burlington Northern Railroad (BNRR) right-of-way. Figure 2 shows existing site features and topography.

1.2 Previous Cleanup Actions

In 1988, Unocal entered into an Order on Consent (Order) with Ecology to remediate petroleum-containing soils and groundwater at the Site. For the purposes of the Order, the Site was divided into the following four compliance areas (shown on Figure 2):

- Upper Yard;
- Elliott Avenue;
- Lower Yard; and
- Off-Site Area (including Alaskan Way and the BNRR right-of-way).

Unocal conducted extensive remedial actions at the Site pursuant to the Order. Approximately 65,000 tons of petroleum-contaminated soils were removed from the Upper Yard beginning in 1989. In general, total petroleum hydrocarbon (TPH) concentrations in soils remaining in the Upper Yard do not statistically exceed 200 mg/kg, the cleanup target for that compliance area. However, a relatively small volume

(estimated at 110 cubic yards) of impacted soils in the northwest corner of the Upper Yard could not be excavated because of its depth (approximately 16 to 26 feet below the adjacent street grade) and proximity to a shoring wall installed along Elliott Avenue. A detailed assessment of the areal and vertical extent of TPH impacted soils remaining in the Upper Yard was presented in the technical memorandum on Remedial Measures to Address Upper Yard Direct Contact and Leaching Concerns (Aspect 2003). Figures 6 and 7 in this EDR reproduce the summary of that analysis.

Amendment No. 4 of Unocal's Order on Consent established a remedial action level (RAL) of 7,500 mg/kg for TPH in Lower Yard soils (while maintaining the 200 mg/kg cleanup target). Between 1989 and 1997, Unocal excavated approximately 60,000 tons of Lower Yard soils exceeding this RAL. TPH concentrations exceeded 200 mg/kg in 31 percent of the confirmation soil samples, with an average concentration of about 900 mg/kg. The upper 95 percent confidence value of the data set was about 1,300 mg/kg, well below the RAL. Following confirmation sampling, Unocal backfilled the Lower Yard with soil materials from several sources. Imported rock was first placed in low-lying areas to an elevation of approximately 8 feet (based on SEANET vertical datum). Approximately 17,800 cubic yards (bulked volume) of stockpiled Lower and Upper Yard soils with an average TPH concentration of about 1,000 mg/kg were then backfilled. Finally, a minimum 2-foot-thick layer of imported "clean" soil (i.e., Class 1 soil per Ecology 1994) was placed over the entire Lower Yard to serve as an interim cap.

Petroleum contamination, including much more extensive LNAPL, has also been encountered in Off-Site Area soils and groundwater. A liquids extraction system installed by Unocal along the west side of the railroad tracks has operated almost continuously since December 1989, reducing the discharge of petroleum contamination to Elliott Bay. As of December 2003, approximately 23 million gallons of water have been extracted, treated, and discharged to the sewer, and approximately 4,800 gallons of LNAPL have been recovered.

1.3 Summary of Phase I Cleanup Action

The Olympic Sculpture Park cleanup action is currently planned to be completed in two phases. The first phase of remediation will address a portion of the cleanup action at the Upper and Lower Yards. The cleanup action is proposed to be completed in two phases to take advantage of the availability of clean fill soil from redevelopment of the former Arcade Plaza property located at 1321 Second Avenue in downtown Seattle. A Phase I Environmental Site Assessment (Hart Crowser 2002a) conducted for the Arcade Plaza and adjacent parking lot identified no previous site uses that would have impacted subsurface soils (Appendix A). In addition, the soil fines content was identified to be ideal for the OSP site soil capping requirements (Appendix B).

It is anticipated that roughly half of the total fill requirement for the Upper and Lower Yard cleanup action will occur during the first phase. Figures 3 and 4 show plan and section views of planned areas of soil placement and anticipated grades upon completion of Phase I construction.

In addition to soil importation and placement, Phase I remediation will include the following elements:

- Installation of erosion control measures to stabilize the Site during Phase I construction;
- Installation of a reduced permeability layer (RPC) within the clean fill layer in the northwest corner of the Upper Yard; and
- Installation of stormwater drain lines and erosion control measures to stabilize the Site during the interim period between Phase I construction and completion of the Upper and Lower Yard remediation planned for 2005.

1.4 EDR Organization

This EDR provides detailed analysis of remedial components discussed in the Cleanup Action Plan (CAP; Exhibit B to the Consent Decree) and identified in the technical remedial design memorandum (Aspect 2003a, 2003b, and 2003c) prepared for the Upper and Lower Yards. Only those remedial components pertinent to Phase I construction are addressed. For example, since no cleanup actions will take place in the Offsite Area during this initial phase, Offsite Area remedial activities are not addressed. A separate EDR will be prepared that addresses final (Phase II) design and construction of the OSP remediation.

This EDR consists of the following sections:

Section 1–Introduction

The introduction (this section) presents general background information, as well as the purpose and organization of the EDR.

Section 2–Cleanup Requirements

Section 2 presents the cleanup requirements pertinent to Phase I construction.

Section 3–Basis of Design

Section 3 presents the basis of design for remedial components that address the cleanup requirements discussed in Section 2, including engineering concepts and criteria.

Section 4–Compliance Monitoring Plan

The compliance monitoring plan (CMP) for Phase I construction is presented in Section 4. Compliance monitoring will be performed to confirm that the remedial components constructed in Phase I conform with the cleanup requirements and engineering criteria discussed in Sections 2 and 3, and that human health and the environment are protected during construction.

Section 5–Schedule

The schedule for the Phase I remedial action is presented in Section 5.

2.0 Cleanup Requirements

2.1 Upper Yard

The CAP identifies the following remedial action objectives (RAOs) for the Upper Yard:

1) Minimize potential for direct contact with residual petroleum-impacted soils in the vicinity of well MW-61A;
2) Minimize potential for leaching of hydrocarbons from residual petroleum-impacted soils in the vicinity of well MW-61A;
3) Prevent potential indoor air impacts; and
4) Verify that ambient air quality meets Washington State Model Toxics Control Act (MTCA) Method B cleanup levels or is within background conditions.

At the time the CAP was issued (October 1999), insufficient information was available to assess ambient air inhalation exposure potential. To provide data needed to address the ambient air RAO, monitoring was conducted in accordance with the Air Sampling/ Monitoring and Contingency Plan (AS/M&CP), included in the Consent Decree as Exhibit F.

The results of the long-term ambient air monitoring conducted in accordance with Exhibit F were summarized in a Technical Memorandum regarding Remedial Measures to Address Inhalation Exposure Concerns (Aspect 2003c). Ambient air concentrations exceeding both the MTCA Method B cleanup levels proposed in the CAP and background levels were measured in the Upper Yard during the monitoring requiring remedial actions to address soil vapor emissions. Therefore, ambient and indoor air controls are required on the Upper Yard.

2.2 Lower Yard

The CAP identifies the following remedial action objectives for the Lower Yard:

1) Further minimize potential for direct contact with residual petroleum-impacted soils;
2) Further minimize potential for leaching of hydrocarbons from residual petroleum-impacted soils;
3) Prevent potential indoor air impacts; and
4) Verify that ambient air quality meets Method B cleanup levels or is within background conditions.

No RAO exceedences were measured in the Lower Yard during the four rounds of ambient air monitoring conducted in accordance with Exhibit F to the Consent Decree. Therefore, only RAOs 1) and 2) are addressed by this design.

3.0 Basis of Design

3.1 Well Decommissioning and Replacement

Unocal is conducting groundwater remediation monitoring as part of on-going remedial activities per an Order on Consent developed with Ecology in 1988. As a result of Unocal's groundwater activities, approximately 48 monitoring wells, 2 recovery wells, and 13 piezometers are currently located throughout the former marketing terminal property.

Figure 5 shows the locations of those monitoring and recovery wells in the immediate vicinity of the Upper and Lower Yards. Only the five highlighted wells (MW-30, MW-33, MW-59, MW-61A, and MW-66) are currently included in Unocal's groundwater monitoring program. Groundwater monitoring is no longer required in the remaining monitoring wells because contaminant concentrations have been either non-detect or below cleanup levels for at least 8 consecutive sampling events (spanning up to 6 years). In addition, five recovery wells (RW-16 and RW-21 through RW-24) have been demonstrated to be ineffective at LNAPL recovery and are no longer in use.

Among the five wells currently being monitored by Unocal, only well MW-61A is within the Phase I construction footprint. The MDA proposes to decommission this well at the start of Phase I construction and replace it at the completion of Phase I. Since additional construction will take place in Phase II at the current MW-61A location, the MDA proposes that the replacement well be installed in the Elliott Avenue sidewalk approximately 12 feet west of the current well location. The replacement well would be screened in the same elevation interval as well MW-61A.

The remaining four wells currently being monitored by Unocal (MW-30, MW-33, MW-59, and MW-66) shall be protected during construction. The MDA requests that Ecology confirm that Unocal may decommission other wells shown on Figure 5 since they are no longer in use.

3.2 Measures to Reduce Leaching Potential in the Upper Yard

The selected remedy described in the CAP includes installation of a reduced permeability layer in the northwest corner of the Upper Yard (i.e., in the vicinity of well MW-61A). Construction elements discussed in the CAP include the following:

- Grade the area to achieve a slope of 3 percent;
- Place a 1-foot-thick reduced permeability layer consisting of granular material with at least 10 percent fines, and having a vertical permeability of 1.2×10^{-4} to 1.0×10^{-6} cm/sec;

- Above the reduced permeability layer, install a 1-foot-thick gravel layer with perforated pipes to collect water and discharge it to sewer; and
- Overlay the gravel layer with filter fabric and a minimum of 3 feet of sandy loam suitable for landscaping.

The CAP envisioned that this would address the leaching RAO by reducing infiltration by about 50 percent.

During the initial phase of OSP design, cleanup measures to reduce leaching potential were further developed/modified, as documented in a technical memorandum to Ecology (Aspect Consulting 2003b). Based on the estimated areal and vertical extent of residual TPH-impacted vadose zone soils (see Figures 6 and 7), the following remedial measures were identified to reduce leaching potential in the vicinity of residual TPH-impacted soils in the Upper Yard:

1) Installation of a reduced permeability cap; and
2) Grading and drainage features to promote surface water runoff.

3.2.1 Reduced Permeability Cap

Figure 8 shows plan and section views of the reduced permeability cap (RPC), which will divert infiltrating water before it reaches residual TPH-impacted soils in the Upper Yard. As discussed below in Section 3.3, a large (approximately 24-feet thick) layer of clean imported fill will be placed in this area to address the ambient air RAO. The RPC will be installed within this clean fill layer, at the approximate grade of Elliott Avenue. It will consist of a minimum 12-inch-thickness of natural or amended earthen material having a vertical permeability of 1×10^{-5} cm/sec or less. Either the natural high silt-clay soils from the Arcade excavation or an amended earthen material such as controlled density fill are proposed to be used.

Boring logs and analysis of the physical properties of soil samples collected from explorations around the perimeter of the former Arcade Plaza property (Appendix A) indicate that the majority of the soil to be excavated is a sandy silt or silty sand with up to 80 percent fines content (see grain size curves in Appendix B). If construction timing is such that these soils are available from the excavation site when the RPC is planned for installation, it is proposed that these be used to construct the reduced permeability layer. Regardless of whether natural or amended earthen material is used, the minimum thickness and maximum vertical permeability criteria stated above will be achieved. Performance monitoring and testing of the RPC is discussed in Section 4.2.3.

The lateral dimensions of the reduced permeability layer will be approximately 57 feet by 190 feet as derived from a rectangle projected upward and outward at an angle of 2 horizontal:1 vertical (2H:1V) from the outermost edges of the underlying impacted soil layer. This is based on the very conservative assumption that water migrating through the unsaturated zone can move laterally at an angle of up to 2H:1V. Note that the rectangular projection intersects the existing ground surface along a portion of its northern edge. Soils will not be excavated to install the reduced permeability layer in this area. Instead, the layer will extend northward to abut the existing ground surface, as shown on Figure 8.

The reduced permeability layer will be sloped to drain at a 3 percent grade as shown on Figure 8. The layer's western edge will abut either the existing shoring wall along Elliott Avenue or another low permeability feature (e.g., bridge footing), thus providing a continuous barrier to infiltration. A perforated pipe oriented parallel to Elliott Avenue will be installed immediately above the layer to drain infiltrating water to sewer. The pipe will be surrounded by filter fabric and gravel, and will drain to the south at a 0.5 percent minimum grade. At the southern edge of the reduced permeability layer the pipe will transition from perforated to solid-wall and will discharge to the combined sewer beneath Elliott Avenue.

3.2.2 Surface Grading and Drainage Features

To reduce infiltration into the area above the reduced permeability layer, a graded slope with a well-drained pathway and vegetation is proposed at the finished park surface to promote surface water runoff. Design of the finished park surface will be addressed in the EDR for final (Phase II) OSP construction.

Surface grading will be performed and drainage features constructed in Phase I to prevent surface water runoff from the Upper Yard and control soil erosion during the interim period between Phase I and Phase II construction. As depicted on Figure 3, interim surface grading and drainage features will include the following:

- The relatively flat finished fill surface will be graded to promote surface water drainage away from the fill area perimeter to a central detention area, where a portion of the water will enter a perforated riser pipe;
- Fill placed along the east side of Elliott Avenue will be graded to promote surface water drainage to a collection point south of the reduced permeability layer, where the water will enter a second perforated riser pipe; and
- Fill soil will not be placed in the immediate area around the eastern end of the Unocal pipe tunnel. This is necessary to allow access for the pipe tunnel to be filled during final (Phase II) construction.

Water entering the perforated riser pipes will be routed to the combined sewer beneath Elliott Avenue. Thus, the majority of surface water that collects in the northwest corner of the Upper Yard under the current condition will be diverted away from that area. A portion of it will infiltrate in other areas of the Upper Yard, and a portion will be captured and routed to sewer. As a result, infiltration into the area above the reduced permeability layer will be substantially reduced upon completion of Phase I construction.

3.2.3 Amendment to Restrictive Covenant

The Restrictive Covenant for the Upper Yard (Exhibit D to the Consent Decree) contains an institutional control to protect the reduced permeability layer. Section 1 of the Restrictive Covenant prohibits any activity on the property that could potentially compromise the layer. It states:

> *Some examples of activities that are prohibited in the capped area include: drilling, digging, placement of any objects or use of any equipment which deforms or stresses the surface beyond its load-bearing capability, piercing the surface with a rod, spike, or similar item, bulldozing or earthwork.*

Since the current design calls for covering the reduced permeability layer with over 20 feet of imported fill material, most of these examples of prohibited activities will no longer be of concern. Therefore, it is proposed that the Restrictive Covenant be amended to include a figure showing the areal extent and depth of the reduced permeability layer, and to prohibit any activity that may compromise this layer.

3.3 Measures to Reduce Soil Vapor Emissions in the Upper Yard

Ambient air monitoring indicated that remedial action addressing soil vapor emissions is required in the Upper Yard. The remedial action design basis was developed in a technical memorandum to Ecology (Aspect Consulting 2003c). Portions of that memorandum pertinent to Phase I construction are presented in this section.

The air quality exceedences measured in the Upper Yard likely resulted from soil vapor emissions emanating from localized zones of residual soil contamination. Based on information obtained during Unocal's 1997 remedial action (GeoEngineers 1997) and a 2002 investigation conducted in the vicinity of the proposed OSP Pavillion (Hart Crowser 2002b), the following two zones (shown on Figure 9) were identified as having the highest potential for significant soil vapor emissions to the Upper Yard:

- **Zone 1.** This zone, located in the Upper Yard's northwest corner, contains impacted soil that could not be excavated from the Upper Yard, impacted soil behind (i.e., west of) the existing shoring wall, and the eastern end of the Unocal pipe tunnel that runs beneath Elliott Avenue.
- **Zone 2.** This zone, located along the Yard's northern boundary, contains petroleum-impacted soil behind (i.e., immediately north of) the existing shoring wall.

As shown on Figure 9, three confirmation surface soil samples located within the Upper Yard but outside the above zones had TPH concentrations in excess of the 200 mg/kg cleanup target. However, the highest TPH detection among these was only 369 mg/kg and PID headspace measurements did not exceed 100 ppmv. Therefore, these three locations are judged to have a much lower potential for soil vapor emissions than the two zones described above. Similarly, perimeter soil in the vicinity of Boring B-101, which exhibited a maximum PID headspace measurement of 92 ppmv, is judged to have a low potential to impact Upper Yard ambient air.

3.3.1 Proposed Remedial Action and Required Emission Reductions

It is proposed that a layer of well-compacted clean fill be added to the Upper Yard to reduce soil vapor emissions and achieve the ambient air RAO. The fill layer will reduce the rate at which petroleum hydrocarbon vapors are emitted to ambient air from the potential source areas discussed above. The emission reductions that must be achieved by the fill layer to meet the MTCA Method B air cleanup levels are as follows:

Analyte Group	Required Emission Reduction
C_8-C_{10} Aliphatics	82%

C_{10}-C_{12} Aliphatics	35%
C_8-C_{10} Aromatics	20%

The magnitude of emission rate reduction achieved by placing a fill layer over a vapor source is dependent on both the fill layer thickness and its physical properties. To calculate emission reductions under various scenarios, we used Fick's Law of molecular diffusion in accordance with EPA guidance on soil vapor emissions from contaminated sites (EPA 2000). The analysis was conducted for the two localized areas having the highest potential for significant soil vapor emissions to the Upper Yard (Zone 1 and Zone 2). The detailed analysis can be found in the technical memorandum regarding remedial measures to address inhalation exposures (Aspect 2003c).

The evaluation process involved iteratively specifying fill soil properties to determine the minimum thicknesses of additional fill at Zones 1 and 2 to achieve the required emission reduction efficiencies. Since there is more than one independent variable in this evaluation, there is a range of potential solutions. For example, for a given fill layer thickness, tradeoffs can be made between the soil fines content and its compaction to achieve the same emission reduction efficiency. However, in order to avoid undue complexity in the requirements of the construction bid package, a single set of soil property limits were determined that meet the emission reduction criteria while providing the contractor flexibility in selecting among fill soils that may be available at the time of park construction.

3.3.2 Proposed Fill Soil Thicknesses and Limits

Based on the required emission reductions and analyses (Aspect 2003), the following fill soil thicknesses and limits are proposed:

- Minimum fill layer thicknesses of 29 feet at Zone 1 and 7 feet at Zone 2 (these thicknesses apply to the finished OSP grades relative to existing grades);
- Fill soil having a minimum fines content of 5 percent by weight and a water content (at the time of placement) of no less than 1 percent greater than the optimum water content for soil compaction (per ASTM D1557); and
- Soil compaction to at least 90 percent of the Modified Proctor Density (ASTM D1557).

The requirements for minimum fines content, water content, and compaction will be applied to all fill soils placed in the Upper Yard north of the east-west boundary line shown on Figure 9. This boundary line is conservatively located 100 feet south of the southernmost corner of Zone 1 to assure that potential emissions from both Zones 1 and 2 are adequately addressed. The proposed minimum fill thickness requirements (29 feet at Zone 1 and 7 feet at Zone 2) are not applicable to Phase I construction but will be achieved by the finished OSP construction.

Based on boring logs and analysis of the physical properties of soil samples collected from explorations around the perimeter of the former Arcade Plaza property (Appendix B), the majority of soils excavated from that property are expected to meet the proposed minimum fines and water content criteria. Fill soils entering the Site will be field-screened for fines content. Soils with low fines content will be placed in the southern

portion of the Upper Yard and/or in the Lower Yard. If necessary, water will be added to soils at the time of placement in the northern portion of the Upper Yard to achieve the water content criterion. Performance monitoring, including periodic laboratory testing, will be conducted prior to import, and during placement and compaction of fill soils in the northern portion of the Upper Yard, as discussed (see Section 4.2.3)

3.4 Measures to Reduce Direct Contact Potential in the Upper Yard

As discussed above, a large (approximately 29-feet-thick) layer of clean imported fill is proposed in the vicinity of well MW-61A to address the ambient air RAO. In addition, a reduced permeability layer will be installed within this clean fill layer, and a restrictive covenant will prohibit any activity that may compromise the reduced permeability layer. These features will provide more than adequate protection against direct contact exposure to residual impacted soil in this portion of the Upper Yard.

3.5 Measures to Reduce Direct Contact and Leaching Potential in the Lower Yard

The design basis for reducing direct contact and leaching potential in the Lower Yard was developed in a technical memorandum to Ecology regarding remedial measures to address Lower Yard direct contact and leaching concerns (Aspect Consulting 2003a). Portions of that memorandum pertinent to Phase I construction are presented in this section.

3.5.1 Measures to Reduce Direct Contact Potential

To reduce direct contact potential, it is proposed to place additional clean fill over the entire Lower Yard area. A minimum 1-foot thickness of additional clean fill is proposed which, along with the clean fill layer already in place, will bring the total cover soil thickness to a minimum of 3 feet.

3.5.2 Measures to Reduce Leaching Potential

To reduce the potential for residual contaminants in soil to leach into groundwater, it is proposed that the park design include surface grading and drainage features that promote runoff of surface water from the Lower Yard area, thereby reducing infiltration. Design of the finished park surface will be addressed in the EDR for final (Phase II) OSP construction.

Similar to the Upper Yard (discussed in Section 3.2.2), Phase I surface grading will be performed and drainage features constructed in the Lower Yard to prevent surface water runoff and control soil erosion during the interim period between Phase I and Phase II construction. As depicted on Figure 3, interim surface grading and drainage features will include the following:

- The relatively flat finished fill surface will be graded to promote surface water drainage away from the fill area perimeter to a central detention area, where a portion of the water will enter a perforated riser pipe;

- Fill placed along the east and west sides of the Lower Yard will be graded to promote surface water drainage to central collection points, where the water will enter perforated riser pipes; and
- Fill soil will not be placed in the immediate area around the western end of the Unocal pipe tunnel. This is necessary to allow access for the pipe tunnel to be filled during final (Phase II) construction.

Water entering the perforated riser pipes will be routed to the combined sewer beneath Elliott Avenue. Thus, a significant portion of surface water that collects in the Lower Yard under the current condition will be captured and routed to sewer. As a result, leaching potential will be significantly reduced upon completion of Phase I construction.

3.5.3 Amendment to Restrictive Covenant

Section 1 of the Restrictive Covenant for the Lower Yard (Exhibit D to the Consent Decree) prohibits any activity on the property that may result in the release or exposure to the environment of residual TPH-contaminated soil. It states:

> *Some examples of activities that are prohibited in the capped area include:drilling, digging, placement of any objects or use of any equipment which deforms or stresses the surface beyond its load-bearing capability, piercing the surface with a rod, spike, or similar item, bulldozing or earthwork.*

It is proposed that the Restrictive Covenant be amended to include a figure showing clean fill thicknesses placed in the Lower Yard. Activities that may result in exposure to underlying TPH-contaminated soil would be prohibited as described above. The revised institutional controls would allow activities, such as installing sculpture foundations and plantings, in areas where fill is much thicker than 3 feet, and would identify the actions, prohibitions, and agency notifications that must occur if the property owner will alter the 3 foot cap.

4.0 Compliance Monitoring Plan

This section presents a summary of the compliance monitoring to be performed during Phase I construction. Compliance monitoring can be broken down as follows:

- **Protection Monitoring** to confirm that human health and the environment are protected during cleanup construction;
- **Performance Monitoring** to confirm that cleanup construction has attained the cleanup requirements prescribed in the CAP; and
- **Confirmation Monitoring** to confirm the long-term effectiveness of the cleanup action.

Only protection and performance monitoring are associated with Phase I construction of the OSP. Confirmation monitoring will be addressed in the EDR for final (Phase II) design and construction.

4.1 Planned Protection Monitoring Activities

Protection monitoring for human health will be implemented by ensuring that site workers are trained in health and safety and follow a site-specific health and safety plan. Access to the site will be controlled by security fencing.

Impacted media identified at the Site include soil, groundwater, and ambient air. The only Phase I cleanup activity in which potential exposure to groundwater containing LNAPL could occur is in the replacement of monitoring well MW-61a. In addition to these liquids, installing the replacement well will likely generate a relatively small quantity of impacted soil cuttings. Generated media (soil cuttings and liquids) will be drummed, characterized, and appropriately disposed of off-site.

Apart from monitoring well replacement, the only invasive work planned in Phase I is that associated with installation of the storm drain pipes. Installation of pipes within the Upper and Lower Yards is not a concern since they will be placed either on the existing ground surface or on fill soils (i.e., no excavation of existing soils). Pipes installed in the Upper Yard will be routed to the combined sewer beneath Elliott Avenue via an existing side-sewer connection, so only very minor excavation of existing soils will be required. Some excavation beneath Elliott Avenue will be necessary to install a storm drain pipe from the Lower Yard to the existing combined sewer (see Figure 3). This is the only construction segment where significant soil excavation is anticipated. The sewer connection will be made between the soil borings HC-SB12 and HC-SB13 depicted on Figure 6. As shown on that figure, contamination was not encountered in soil samples collected from these two borings. Therefore, while the potential exists, available data suggest that it is unlikely that impacted soil will be encountered during excavation for this sewer connection.

It is also possible, although unlikely, that one or more truckloads of imported fill soils may be found to be contaminated (Section 4.2.1).

Potentially-contaminated soils, if encountered during excavation or fill importation, will be temporarily stored in a designated stockpiling area that has appropriate contact and runoff controls. In addition, soil stockpiles will be managed in a manner to ensure protection of human health and the environment (e.g., minimize dust generation).

As discussed in Section 3.3.1, Method B ambient air cleanup levels developed for three petroleum hydrocarbon fractions (C_8-C_{10} aliphatics, C_{10}-C_{12} aliphatics, and C_8-C_{10} aromatics) were exceeded in the Upper Yard during ambient air monitoring. The largest measured exceedence, for C_8-C_{10} aliphatics, was 740 µg/m^3, or about 5.4 times the corresponding cleanup level. The cleanup levels address risks associated with unrestricted (e.g., residential) use of the Site, and were developed assuming lifetime exposure to the contaminants. Contaminant concentrations measured at the Site during ambient air monitoring do not exceed any worker exposure limits, and do not represent a short-term exposure concern. Therefore, it is proposed that routine ambient air monitoring (photo-ionization detector (PID) field screening) be conducted only during certain construction activities, including replacement well installation, soil excavation (e.g., for the Lower Yard storm sewer connection beneath Elliott Avenue), and handling of potentially-contaminated soils (if encountered).

4.2 Planned Performance Monitoring Activities

Performance monitoring will be conducted in the following areas:

- Field-Screening of Imported Fill Soils;
- Field-Screening of Excavated Soils;
- Installation of Reduced Permeability Layer in Upper Yard;
- Soil Placement and Compaction in Northern Portion of Upper Yard; and
- Contingency Plan for Potentially-Contaminated Soils.

4.2.1 Field Screening of Imported Fill Soils

Only clean soils, free of debris, will be specified as fill import to the Site. To ensure the imported soil is clean, field screening for evidence of soil contamination will be conducted both at the former Arcade Plaza property (as soil is being excavated and loaded into trucks) and at the Site (as the loaded trucks arrive). Soils will be inspected for debris, petroleum sheens, staining, and odor. In addition, the headspace of jar samples collected from any suspect soils will be monitored for organic vapors using a PID. We understand that soils excavated at the former Arcade Plaza property will be field screened also (contractor and geotechnical engineer are the same for both projects); and that any soils containing debris or any evidence of potential contamination will not be sent to the OSP Site. However, in the event that such soils are identified in a loaded truck arriving at the Site, they will be managed in accordance with the procedures discussed in Section 4.2.5.

Each truckload of fill arriving at the Site will also be field-screened for fines content to determine whether it is suitable for placement in the northern portion of the Upper Yard. Fill placed in this area of the Site must have a minimum fines content of 5 percent by weight to address soil vapor emissions concerns. Boring logs and physical analysis of soil samples collected from explorations around the perimeter of the former Arcade Plaza property (see Appendix B) indicate that a large portion of the soils to be excavated will likely meet this criterion.

In addition to field screening, fill materials placed in the northern portion of the Upper Yard will be periodically sampled and submitted for laboratory analysis of fines content. This is discussed in Section 4.2.4.

4.2.2 Field Screening of Excavated Soils

Although unanticipated, contamination and/or debris may be encountered during excavation of Site soils, including excavation from beneath Elliott Avenue to connect the Lower Yard storm drain to the combined sewer. Field screening for evidence of contamination will be conducted during all Site excavation activities. Soils will be inspected for debris, petroleum sheens, staining, and odor, and soil headspace in jar samples will be monitored using a PID. If suspect soils are encountered, they will be stockpiled separately and managed in accordance with the procedures discussed in Section 4.2.5. Contaminant control measures will be implemented as needed during excavation of potentially contaminated soils. These may include modification of the excavation method, dust and vapor emission suppression, runoff controls, and other measures.

4.2.3 Installation of Reduced Permeability Layer in Upper Yard

As discussed in Section 3.2.1, the reduced permeability layer in the northwest corner of the Upper Yard will consist of a minimum 12-inch thickness of natural or amended earthen material having a vertical permeability of 1×10^{-5} cm/sec or less. The following performance monitoring activities will be conducted to verify that these criteria are met:

- **Vertical Permeability of Amended Earthen Material**. In the event that an amended earthen material such as controlled density fill (CDF) is used, a guarantee will be obtained from the material supplier that the mix design will meet the permeability criterion. The material will be mixed and the reduced permeability layer constructed in accordance with the supplier's recommendations.
- **Vertical Permeability of Natural Earthen Material**. The use of unamended high-clay-content soils excavated from the former Arcade Plaza property to construct the reduced permeability layer would require laboratory and field testing to confirm that the vertical permeability criterion is achieved. In the event that the construction contractor elects to pursue this option, high-clay-content soils in sufficient quantity to construct the layer (400 to 500 cubic yards) will be collected and tested prior to their transport to the site. Three representative soil samples will be collected from the Arcade site during installation of the soldier pile walls used for the excavation shoring. These soils will be submitted for determination of Modified Proctor Density (ASTM D1557), Atterberg Limits, and hydraulic conductivity testing. The material submitted for the hydraulic conductivity testing will be compacted at 85 to 90 percent

of the Proctor density. The results will be used to identify the compaction and Atterburg limits required to achieve the vertical permeability criterion for those soils suitable for construction of the RPC. Following placement of the RPC, a nuclear densometer will be used to confirm that the required compaction has been achieved. The minimum frequency of field compaction testing will be one test per lift per 1,000 square feet.

If the required soil compaction and/or vertical permeability is judged not to be achievable (prior to layer construction), or if verification testing indicates that it cannot be achieved, an amended earthen material such as CDF will be used to construct the reduced permeability layer, as described above.

4.2.4 Soil Placement and Compaction in Northern Portion of Upper Yard

As discussed in Section 3.3.2 , fill placed in the northern portion of the Upper Yard will have a minimum fines content of 5 percent by weight, and a water content (at the time of placement) of no less than 1 percent greater than the optimum water content for soil compaction (per ASTM D1557). In addition, compaction to at least 90 percent of the Modified Proctor Density (ASTM D1557) will be achieved. The following performance monitoring activities will be conducted to verify that these criteria are met:

- **Laboratory Testing Prior to Soil Excavation**. During installation of perimeter soldier piles for excavation shoring at the former Arcade Plaza property, selected soil samples will be submitted for determination of Modified Proctor Density (ASTM D1557). Before bringing fill soil to the OSP Site, the contractor will submit the modified Proctor Density test data for the soils intended as fill cover for emissions control to ensure that the fill material meets the soil fill capping criteria.
- **Field Screening of Fines Content.** As discussed in Section 4.2.1, each truckload of fill arriving at the Site will be field-screened for fines content. Trucks containing fill that is conservatively judged to have less than 5 percent fines by weight will be directed to another area of the Site.
- **Laboratory Verification of Fines Content.** Representative grab samples of soil placed in the northern portion of the Upper Yard will be submitted for laboratory determination of fines content to verify that the 5 percent minimum criterion is being achieved. The minimum frequency of fines content testing will be one test per 1,000 cubic yards of fill placed. Roughly 15,000 to 20,000 cy of fill are expected to be placed within the emissions reduction area.
- **Field Verification of Soil Compaction and Water Content**. Fill will be placed in 8- to 16-inch lifts and compacted. (If necessary, water will be added prior to compaction.) Following lift compaction, a nuclear densometer will be used to confirm that the compaction and water content criteria have been achieved. The minimum frequency of nuclear densometer testing will be one test per 10,000 square feet of each lift of fill compacted.

4.2.5 Contingency Plan for Potentially Contaminated Soils

This section addresses procedures that will be followed in the event that potentially contaminated soils are encountered during construction. Generation of potentially contaminated soils is not anticipated except for a small quantity of drill cuttings associated with the replacement of monitoring well MW-61A. However, possible sources of contaminated soils include fill imported to the Site, surface soils impacted by fuel spills during construction, and soils excavated from beneath Elliott Avenue to connect the Lower Yard storm drain to the combined sewer.

A specific area of the Site will be identified for temporary stockpiling of any soils identified as suspect based on visual and olfactory screening. Stockpiles shall be constructed to isolate stored soils from the environment including:

- A chemically resistant bottom geomembrane liner. Non-reinforced geomembrane liners shall have a minimum thickness of 20 mil. Scrim reinforced geomembrane liners shall have a minimum weight of 40 pounds per 1,000 square feet. The ground surface on which the geomembrane is placed shall be free of rocks greater than 0.5 inch in diameter and any other object that could damage the membrane.
- Geomembrane cover to prevent precipitation from entering the stockpile. Non-reinforced geomembrane liners shall have a minimum thickness of 10 mil. Scrim reinforced geomembrane liners shall have a minimum weight of 26 pounds per 1,000 square feet. The cover material shall be anchored to prevent it from being removed by wind.
- Impermeable berms a minimum of 12 inches in height constructed around stockpiles to contain any liquid which might drain from the soils. Berms shall also be constructed to prevent stormwater from entering soil stockpiles.
- Liquid that collects within the bermed stockpile area shall be removed, temporarily stored, tested and disposed of, as appropriate, based on testing results.

Because limited suspect soil is expected to be encountered, sampling will be conducted on a representative grab sample of any soil material suspected to be contaminated. One sample for every 10 cy of suspect soil will be obtained. The soil will be stockpiled pending results of the sample analysis.

Chemical analyses will be selected based on field observations and PID screening as follows:

- If petroleum contamination is suspected, the soil samples will be analyzed for BTEX by EPA Method 8021 or 8260, for TPH in the gasoline range by Method NWTPH-G, and by TPH in the diesel and heavy oil ranges by Method NWTPH-Dx. Concentrations will be compared with the Lower Yard soil cleanup levels provided in Consent Decree CAP as summarized in Table 1.
- If soil containing debris is observed (other than the soldier piles and concrete debris generated from the OSP site), a representative sample of the debris-containing soil will be collected and analyzed for diesel and heavy oil range petroleum using Method NWTPH-Dx, poly-aromatic hydrocarbons (PAHs) using EPA Method 8270, and

selected metals (Pb, As, Cd, Cr, and Hg) using EPA Method 6020. Concentrations will be compared to MTCA Method A levels.

Stockpiles exceeding these cleanup levels will be disposed of at a suitable permitted landfill or soil recycling facility. If these cleanup levels are not exceeded in any soil sample, the stockpile will be used as fill on the Lower Yard.

5.0 Schedule

As discussed above, OSP construction will be completed in two phases. Anticipated dates for project milestones are as follows:

- Finalize EDR for Phase I Construction — April 2004
- Conduct 30-Day Public Comment Period — May 2004
- Conduct Phase I Construction — mid-June to October 2004
- Finalize Design Documents for Phase II Construction — November 2004
- Conduct 30-Day Public Comment Period — December 2004
- Conduct Phase II Construction — February to June 2005

6.0 Limitations

Work for this project was performed and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Seattle Art Museum and the Museum Development Authority for specific application to the referenced property. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

7.0 References

Aspect Consulting 2003a. Memorandum Re: Remedial Measures to Address Lower Yard Direct Contact and Leaching Concerns, Former Unocal Seattle Marketing Terminal Property. February 21, 2003.

Aspect Consulting 2003b. Memorandum Re: Remedial Measures to Address Upper Yard Direct Contact and Leaching Concerns, Former Unocal Seattle Marketing Terminal Property. April 7, 2003.

Aspect Consulting 2003c. Memorandum Re: Remedial Measures to Address Inhalation Exposure Concerns, Former Unocal Seattle Marketing Terminal Property. June 10, 2003.

Ecology 2004. Letter from B. Sato to D. Carlisle (GeoEngineers) regarding Proposed Ground Water Monitoring Schedule 2004, Unocal Former Seattle Marketing Terminal, Seattle, Washington. February 25, 2004.

GeoEngineers 2004. Progress Report No. 84, Former Unocal Seattle Marketing Terminal 0724, 3001 Elliott Avenue, Seattle, Washington. January 30, 2004.

Hart Crowser 2002a. Memorandum Re: Preliminary Environmental Assessment (Phase I), Arcade Plaza Building and Parking Lot, 1321 Second Avenue, Seattle, Washington. April 19, 2002.

Hart Crowser 2002b. Memorandum Re: Subsurface Conditions, Settlement Estimates for Bridges and Elliott Tunnel Infilling, Olympic Sculpture Park. September 27, 2002.

Hart Crowser 2003b. Geotechnical Engineering Report, Washington Mutual Office Building, Seattle, Washington. August 13, 2003.